Safe disposal of spent nuclear fuel – The KBS-3 method

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SKB

Why SKB?

§ The nuclear power industry is responsible for taking care of its own waste.

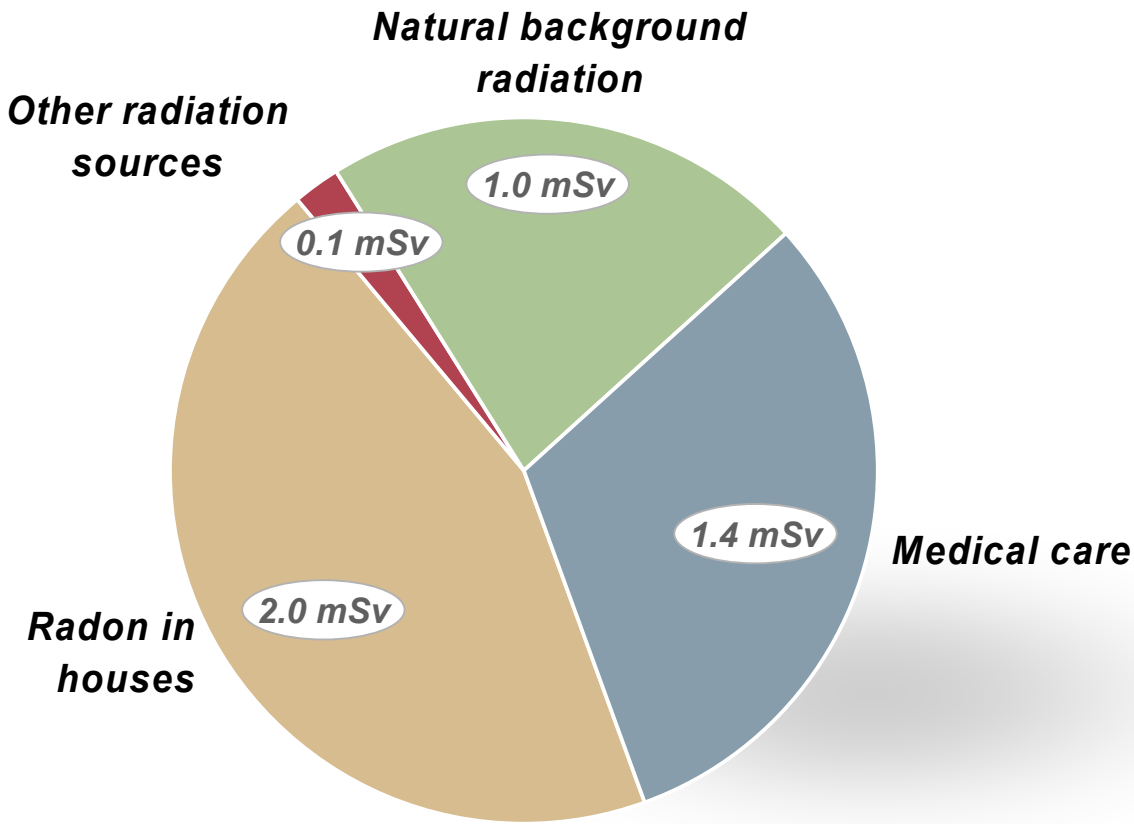
The industry has formed SKB to fulfill this task

Legal requirements in Sweden

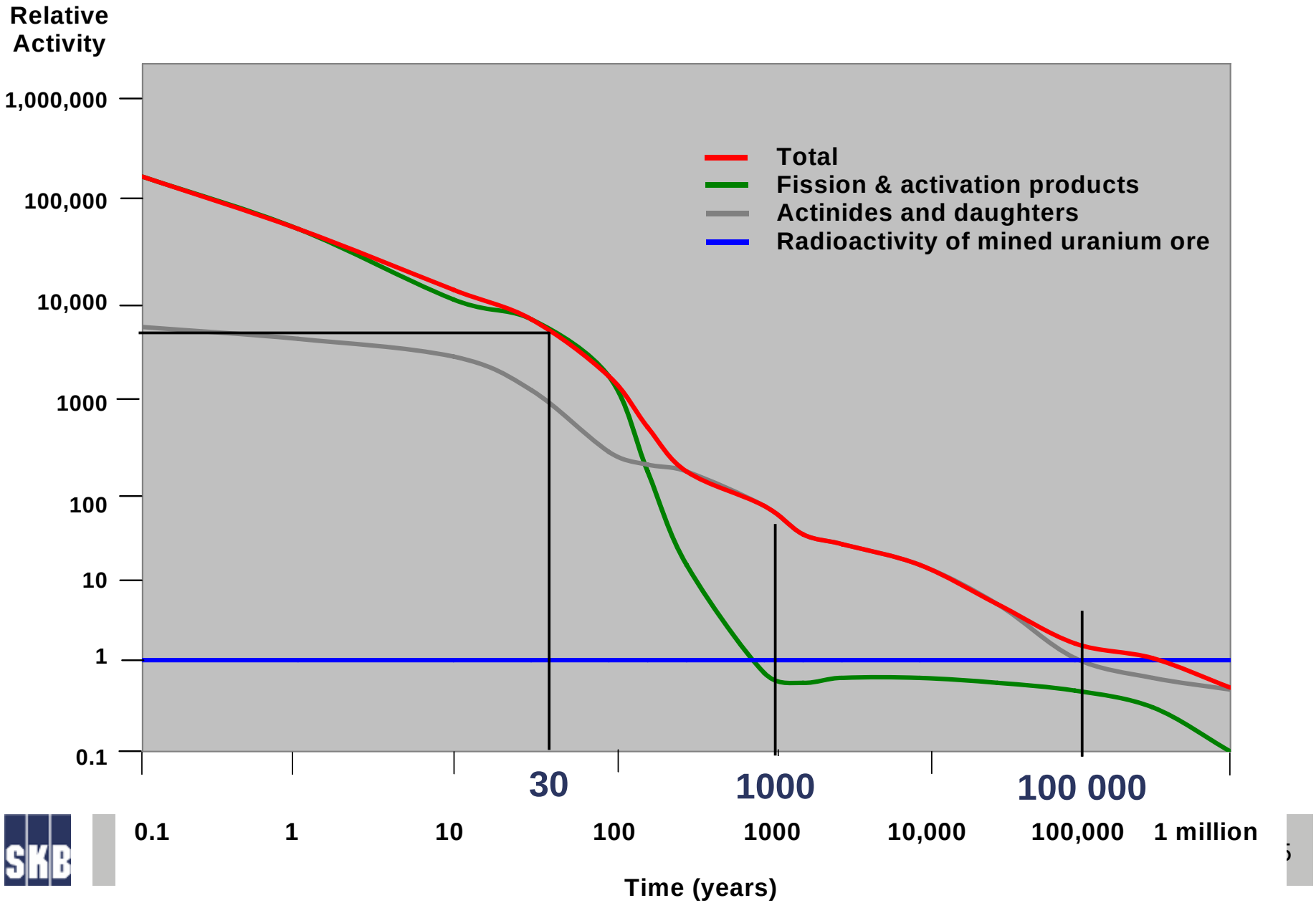
- The annual risk from a final repository should not exceed 10^{-6} for a representative individual in the group exposed to the greatest risk
  - The natural radiation in Sweden is about 1 mSv/year
  - The regulatory limit corresponds to approximately 100th of the natural background radiation

The average Swede's annual radiation dose

≈ 4.5 mSv



Activity of Spent Fuel – the time perspective



Assessment period

- SSI and SKI regulations
  - Quantitative for up to 100 000 years
  - Qualitative for up to 1 million years

Safety functions

- Primary safety function is isolation from man and environment
- If isolation is breached the repository should retard potential radionuclide release from the repository
- The spent fuel should be protected from effects of societal change and long term changes in climate

Redundancy

- The repository should have several barriers that individually and together contribute to the isolation and retardation
- The repository system should have several barriers so that uncertainties in the long term function of a barrier or deficiencies in a single barrier does not result in unacceptable consequences.
- The barriers should be passive, i.e. function without human intervention or supply of materials or energy.

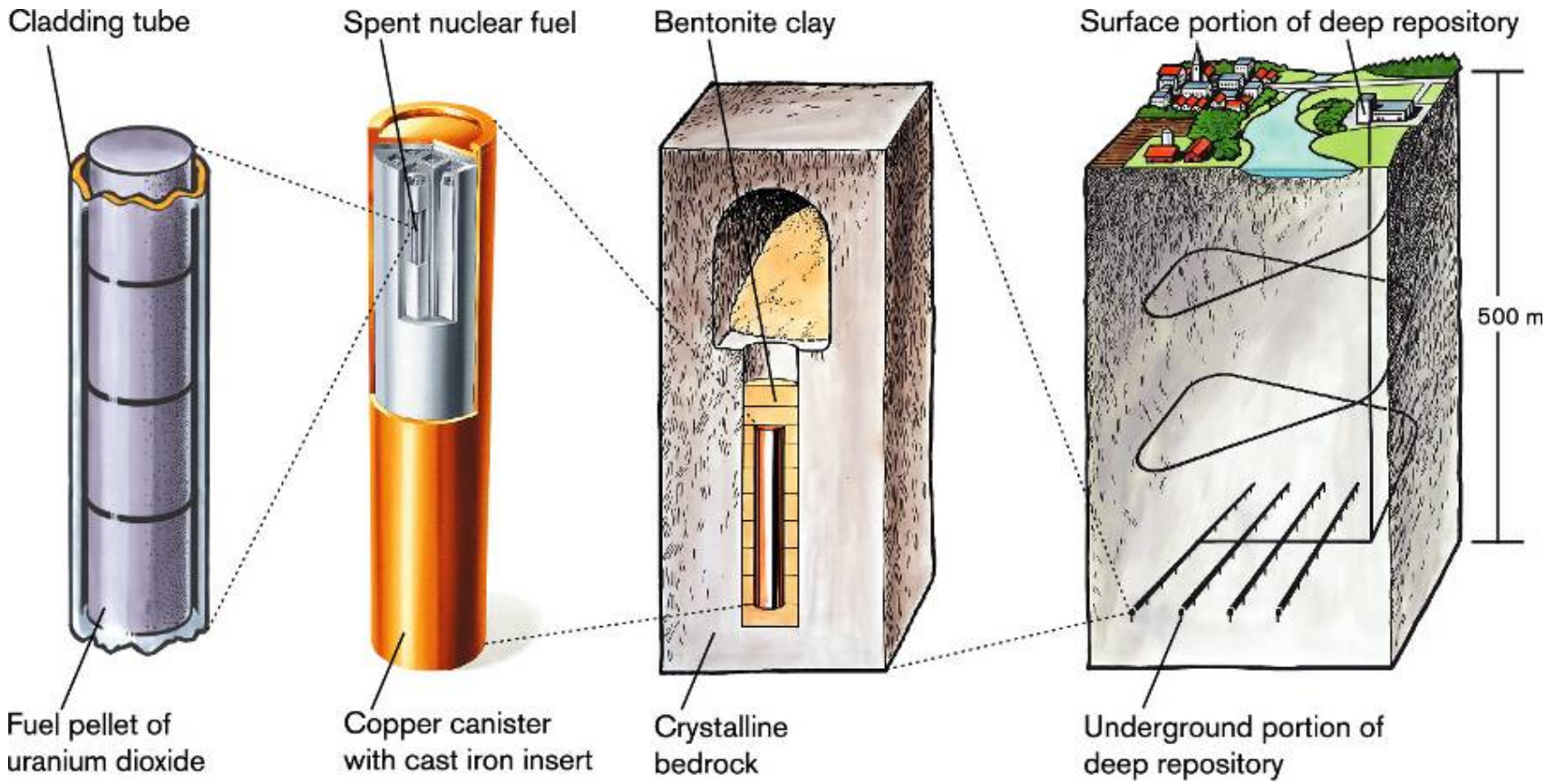
Verified knowledge

- The engineered barriers should consist of naturally occurring materials that can be shown to be stable in the repository environment
- There should exist a scientific knowledge of the processes that can affect the barriers in a long term perspective

Safety and control

- The properties on the host rock and the engineered barriers should be possible to verify
  - It should be possible to verify that the repository initially has the expected properties
- Reliable equipment should be used
- The should be procedures for control of the deposition process to show that it meets requirements

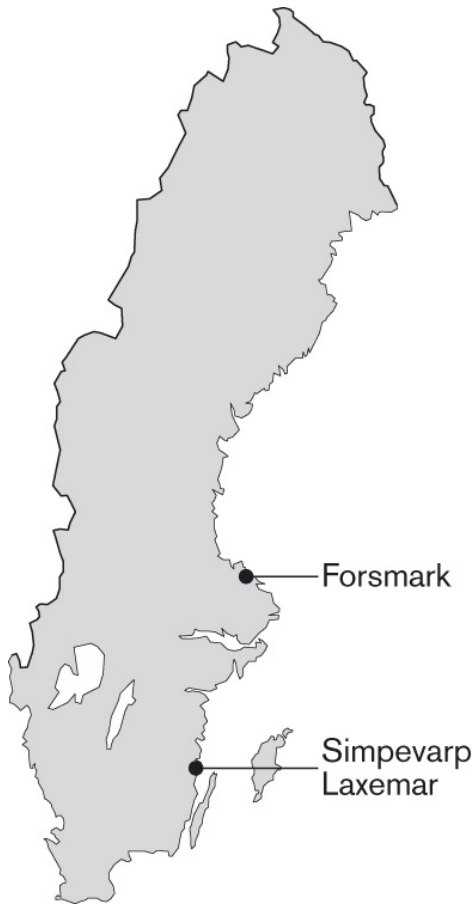
The KBS 3 repository



- Primary safety function: Isolation
- Secondary safety function: Retardation

SR-Can safety assessment

- Site investigations at Forsmark and Oskarshamn progressing according to plan
  - SR-Can is based on data from the initial site investigation stage
- SR-Can is a preparatory step for the SR-Site assessment. SR-Site will support SKB's application for a final repository, planned for 2009.
- SR-Can is not part of any application
- SR-Can is reviewed by SKI and SSI



Conclusions;
Compliance with regulatory risk criterion

- No canisters are assessed to fail during the initial temperate period, expected to last several thousand years
- A repository at Forsmark is assessed to comply with the regulatory risk criterion
- A repository at Laxemar is preliminarily assessed to comply with the regulatory risk criterion – but more representative data is required

Friction Stir Welding – a new welding method

Criteria for evaluation

- Quality of welds
- Reliability in production
- Suitability in the encapsulation process
- Costs and environmental impact

Good rock – locally

- Storage adapted to match local conditions
- Canister positions selected in good rock

Conclusions SR-Can;
Issues related to glacial conditions

- Freezing of an intact buffer is assessed as ruled out – even for very pessimistically chosen climate conditions
- Canister failure due to isostatic load is assessed as ruled out – even for very pessimistically chosen climate conditions
- Oxygen penetration is preliminarily assessed as ruled out – even for very pessimistically chosen conditions
- The risk contribution from earthquakes is assessed to be small
- Loss of buffer may occur from exposure to glacial melt waters but the extent is uncertain – further studies are required
- Substantial loss of buffer may lead to canister failures in very long time perspectives
- An prolonged period of warm climate (increased greenhouse effect) before the next glacial period is assessed to be primarily beneficial for repository safety

Conclusions SR-Can; Other issues related to barrier performance and design

- Crucial to avoid deposition positions intersected by large or highly water conductive fractures – further studies are required
- The heat from the canister may fracture the rock in the deposition hole wall, which may enhance the in- and outward transport of dissolved substances – further studies are required
- The importance of the backfilled deposition tunnels as a transport path for radionuclides is limited
- The importance of the excavation damaged zone in the rock around the deposition tunnels as a transport path for radionuclides is limited

Summary

- The KBS-3 method can provide a safe repository
  - Redundancy – several passive barriers
  - Sufficient scientific understanding of long time perspectives
  - Safety and control in all steps of the deposition process
- Site investigations to be completed summer 2007
- License application end of 2009